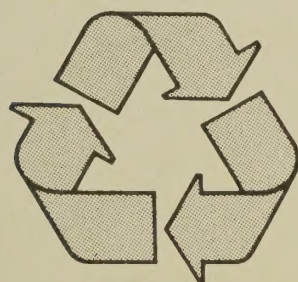


RECYCLING TECHNOLOGY MANUAL



Produced for the
Recycling Advisory Committee
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Toronto, Ontario

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INTRODUCTION

Municipal recycling is a rapidly expanding and evolving waste management alternative in the Province of Ontario. As more municipalities and regional governments recognize the need to include recycling as part of their overall waste management strategy, the number and sophistication of recycling programs continues to grow.

Selection of the right equipment for a recycling operation can be a complex process due to the wide range of options available and the limited operational experience to draw from.

This manual has been written to provide an overview of the technology and equipment available to multi-material recycling operations in Ontario. It is designed to be used as a reference document for any organization planning a new recycling program or expanding an existing one.

The manual is divided into three major sections:

- I. Recycling Program Design
- II. Collection Technologies
- III. Processing Technologies.

In Section I, program design considerations are discussed with respect to their impact on technology selection. Section II provides information on drop-off depots and curbside collection equipment. Processing equipment for newspaper, glass, steel, aluminum and PET, as well as peripheral equipment, is examined in Section III.

For each type of equipment identified in Sections II and III, the following information is provided:

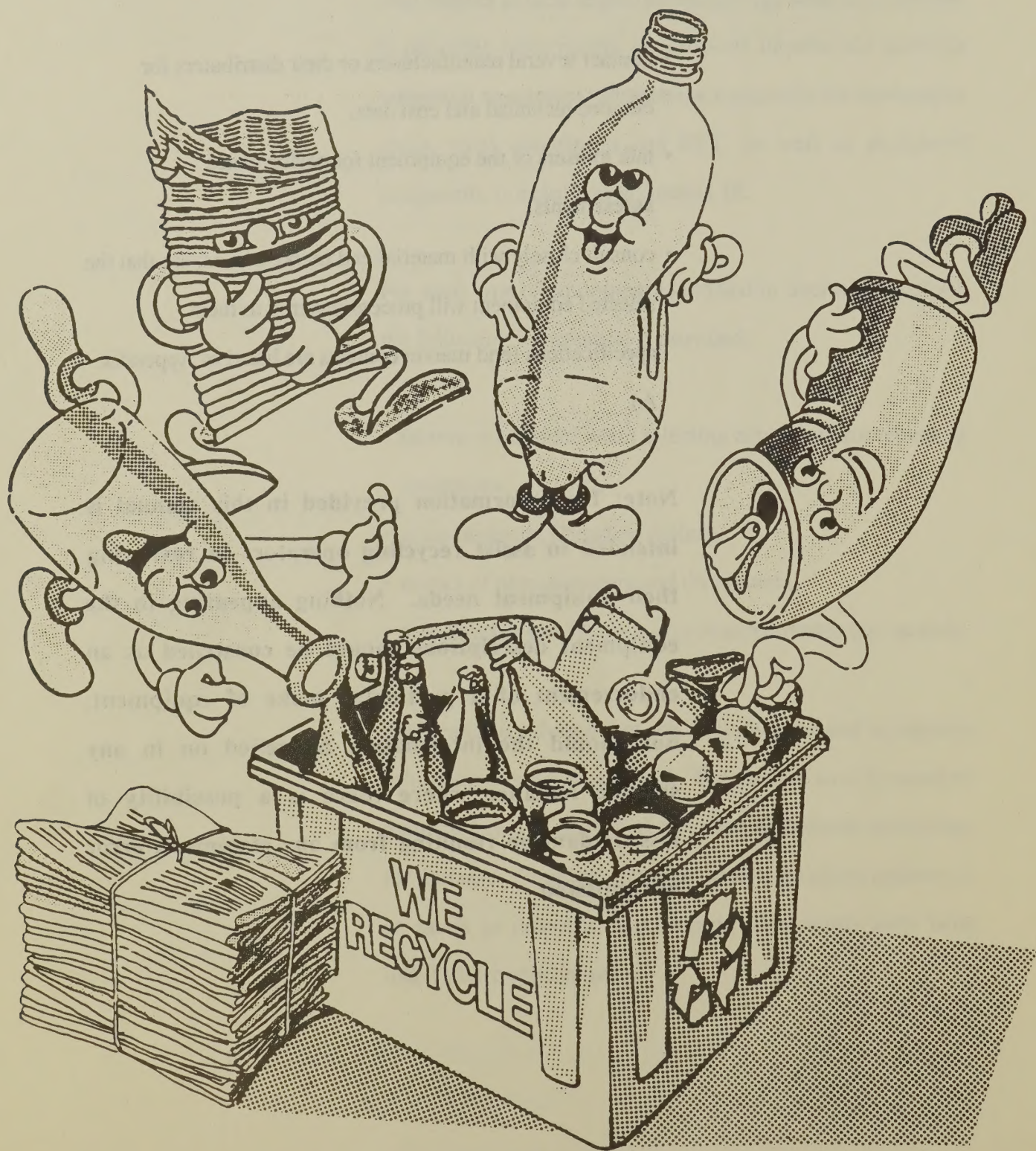
- factors to consider when selecting equipment for recycling operations.
- price ranges in Canadian dollars.
- names of manufacturers and distributors.
- comparative specifications for selected makes and models.

The reader is advised that the manufacturer and equipment information is not exhaustive. The authors have focused on manufacturers of dedicated recycling equipment appropriate for Ontario. Canadian suppliers have been given preference as much as possible, and Ontario distributors have been listed where appropriate.

When making any equipment purchase decision, operators are advised to:

- contact several manufacturers or their distributors for detailed technical and cost data.
- talk to users of the equipment for performance assessments.
- consult closely with material end markets to ensure that the selected equipment will process material to their specifications (end market contacts are listed in Appendix A).

Note: The information provided in this manual is intended to assist recycling operators in reviewing their equipment needs. Nothing appearing in the equipment descriptions should be construed as an endorsement of a particular make of equipment, nor should the information be relied on in any specific instance where there is a possibility of loss or damage resulting from any statement, error or omission.



I. RECYCLING PROGRAM DESIGN

There are five major categories or classes of recycling programs in Ontario. This manual focuses on Class I programs which are defined as having properly advertised weekly multi-material curbside collection of at least newspaper, glass and cans on the same day as garbage day, and using household collection containers. A complete description of program classes is provided in Appendix B.

The overall design of a multi-material recycling program will have a major impact on equipment selection, and therefore a program must be carefully planned prior to the purchase of any equipment. Recycling program design is a function of three key variables:

- potential recovery volumes
- collection methods
- processing methods.

This section provides guidelines for defining these variables and gives the reader a framework for making equipment selection decisions.

Potential Recovery

Potential recovery volumes are influenced by:

- population size and density
- types of materials collected
- sources of generation - residential single family, residential multiple family, commercial, etc.
- the collection methods used
- effectiveness of promotion support program.

There are three basic approaches to determining potential recovery volumes:

- 1) Deduce volumes from waste generation data.
- 2) Estimate volumes from material consumption data.
- 3) Review actual recovery rates of comparable programs.

1) Deduction from Waste Data

This approach involves estimating recovery volumes based on the percentage of recyclable materials in the residential waste stream.

First, per capita residential waste generation rates must be determined. Local waste generation data is the best source, but if such data is not available, an average Ontario residential waste generation rate of 2.2 lbs./person/day (or 803 lbs./person/year) can be used.¹

Second, the percentages of recyclable materials in the waste stream need to be estimated. If possible, this data should be

¹ Guide to Residential Source Separation, Ontario Ministry of the Environment.

obtained from sampling local waste, since levels of materials (particularly newspaper) can vary from community to community. An alternative is to use the percentages of recyclable material in the overall Ontario residential waste stream, which are estimated as follows:

- Newspaper: 10%
- Glass Containers: 7%
- Steel Food and Beverage Cans: 6%
- Aluminum Beverage Cans: To be established
- PET Beverage Containers: To be established

The third factor that must be determined is a realistic recovery rate for each material. Recovery rates are a function of household participation rates and individual material capture rates. Participation rates refer to the percentage of households that participate in the program. Capture rates refer to the percentage of a material that is actually recycled by a participating household.

Participation rates are largely dependent upon the convenience of the recycling collection service for the householder, the effectiveness of the supporting promotion campaign, and the attitudes towards recycling in the community. Some Class I recycling programs in Ontario are currently achieving up to 90% participation levels (ie. 90%

of households set the recycling container out at the curb at least once during a four week collection period).

Drop-off depot programs achieve significantly lower participation rates because of the reduced convenience for householders.

The individual material capture rate in a participating household is also dependent upon attitudes and promotion, and particularly on the level of convenience (i.e. frequency of collection, material preparation requirements, provision of household container). Material capture rates for Class I curbside programs in Ontario are in the following ranges:

• Newspaper:	75-90%
• Glass Containers:	30-50%
• Steel Food and Beverage Cans:	25-35%
• Aluminum Beverage Cans:	To be established
• PET Containers:	To be established

Using the above factors, a potential recovery volume for a material can be estimated according to the following formula:

$$\text{Potential Recovery Volume} = \text{Participation Rate} \times \text{Capture Rate} \times \text{Volume of Material in Waste Stream}$$

2) Estimation from Consumption Data

A second method of estimating recovery volumes is to use material consumption data. Newspaper consumption levels can be obtained from local circulation data. Estimates of PET bottle, glass container and metal can consumption are available from the manufacturers of these materials.

For example, the current average consumption rate of PET bottles in Ontario is five bottles per person per year. At a weight of 2.1 oz. per bottle, approximately 0.6 lb of PET waste will be generated per capita. Since PET bottles are primarily a household container, most of this volume should be recoverable from residential sources.

Actual recovery volumes will again depend on participation and capture rates.

3) Review of Comparable Programs

The third method of estimating recovery volumes is to use actual data from comparable recycling programs currently operating in Ontario.

For example, the following recovery volumes are being achieved by Ontario Class I recycling programs:

- Newspaper: 55-65 lbs/capita/year
- Glass Containers: 12-15 lbs/capita/year
- Steel Food and Beverage Cans: 5-7 lbs/capita/year

- Aluminum Beverage Cans: To be established
- PET Containers: To be established

Multiplying these figures by the population actually serviced will give an estimate of total recovery volumes for a new Class I program.

By using one or more of the above methods, a recycling operator should be able to project recovery volumes for all materials. These data can then be used to plan collection and processing systems.

Collection Methods

Designing the right collection system for a recycling program must also take into account population size and density, types of materials collected and sources of collection, as well as potential recovery volumes.

The only collection methods examined in this manual are depots and curbside collection. Depots are generally used for rural, commercial and recreational areas whereas curbside collection is designed for low density residential areas (single family and low-rise multiple family units).

An effective multi-material collection system for high-rise apartment buildings has yet to be developed. Issues that need to be addressed are: (1) material storage limitations; (2) the level of convenience for residents and maintenance

staff, and (3) efficient collection systems. Pilot projects have been implemented using depots located outside the apartment buildings. Research is currently being done to examine the feasibility of adapting curbside collection vehicles with hydraulic lifts to more effectively service apartment depots.

Drop-off depot siting factors which need to be considered are travel distance for participants, accessibility for collection vehicles and cars, and traffic flow patterns.

Determining the number of collection vehicles needed for a curbside collection program will require a detailed analysis specific to that program. The analysis will have to take into account factors such as number of stops per day, total route miles, truck design and crew size, and the extent of material preparation by householders. Suggested guidelines for material preparation are listed in Appendix C.

A complete discussion of the collection technologies available is provided in Section II of the manual.

Processing Methods The processing system required by a recycling operation is a function of:

- the degree of material separation at the curbside vs. at the processing facility.
- value added by processing.

- market prices and transportation costs.
- material specifications of buyers (either end users or intermediate processors).

The method in which materials are collected influences the processing system. Sorting and loading of materials at the curbside by the truck operator eliminates the need for large scale sorting at the central processing facility and allows segregated materials to be fed directly into the respective processing equipment. In curbside programs, however, the time and space required to sort materials at the collection vehicle increases as the number of recyclables collected increases.

An alternative is to co-mingle materials on the collection truck and sort at the processing facility. This may permit a larger number of materials to be more efficiently collected but requires a more complex processing operation with additional manpower and equipment to properly segregate recyclables.

The desired level of co-mingling depends on several factors. Generally, newspaper is separated at the point of collection, while steel and aluminum are usually co-mingled when collected together. It is also possible to co-mingle various combinations of cans, PET and glass. Determining the

optimal level of curbside separation vs. co-mingling is an area that requires further analysis.

The level of processing required for each material depends on the specifications of end users, transportation costs, and market prices. End market requirements for material currently being recycled in municipal programs in Ontario, or expected to be recycled in the near future, are as follows:

- newspaper - loose or baled
- glass containers - broken or crushed, colour mixed or sorted
- steel cans - flattened, baled or densified
- aluminum cans - flattened, baled or densified
- PET bottles - baled.

Complete specifications are listed in Appendix D. It is advisable to contact end markets directly when selecting processing methods (see Appendix A).

Generally speaking, recycling operations attempt to do the least amount of processing necessary to meet the requirements of buyers and to achieve reasonable transportation efficiencies. Investment in processing equipment should correspond to the relative economic contribution of the material to the overall program and the value added by processing. The cost of additional

processing should always be compared to the incremental net revenue, on a per ton basis.

Opportunities to ship materials to intermediate processors or regional processing centres should also be explored. Due to economies of scale, these operations can often process materials at a lower cost per ton than a small recycling facility.

To the extent that it is possible, operators are advised to invest in equipment that can be adapted to process more than one material. For example, buying a baler that can handle newspaper, steel, aluminum and PET is more cost effective than buying a baler for paper, a flattener for steel, a densifier for aluminum and a granulator for PET. Section III provides a complete description of processing technology options.

It is recommended that municipalities or regions planning a recycling program complete a detailed business plan which encompasses all aspects of the program, in addition to the selection of appropriate technologies.

II. COLLECTION TECHNOLOGIES

An efficient materials collection system is an essential component of any municipal recycling program. The optimum collection system for a given program is dependent on population size and density, as well as the sources, types and volumes of materials collected.

The two methods of collecting addressed in this manual are drop-off depots and curbside collection.

Drop-off depots can serve as a complete collection system in rural areas or complement a curbside program in urban areas. Various depot design options and the vehicles required to service them are evaluated in Section II.A.

Curbside collection is specifically designed for low density residential neighbourhoods. The equipment required - curbside collection vehicles and household recycling containers - are evaluated in Section II.B. The reader is reminded that all prices shown are in Canadian dollars.

A. DROP-OFF DEPOTS

Drop-off depots can be staffed or unstaffed. Staffed depots are usually located in small towns or at processing facilities. Having staff at a depot ensures that the material is properly segregated, but is expensive unless done on a volunteer basis. For this reason, most depots are unstaffed.

While drop-off depots do not achieve the high participation levels of curbside programs, they are a cost effective method of collecting recyclables from rural areas because they allow a portion of the transportation costs to be absorbed by the participants. In urban areas, depots can provide a central storage point for high-rise apartment buildings and can also be used to capture recyclables consumed outside the home - in shopping plazas, factories and public areas.

From a material recovery point of view, the key considerations in establishing a depot system are:

- number of depots in the system
- types of materials collected
- location of depots.

The key consideration from an operator's point of view, however, is the collection and handling system for recovering the materials deposited in the depot.

There are four main options for drop-off depots:

- stationary depots (manual unloading)
- self-dumping depots (mechanical unloading)
- modified portable 40 cu. yd. roll-off containers (mechanical unloading)
- portable collection bins (mechanical unloading).

Stationary Depots

The most commonly used depot design in Ontario consists of a simple shell constructed of metal, wood or fiberglass with separate holes or shutes for each material being recovered. Materials can be deposited directly into the shell and shovelled out when the depot is full (eg. City of Toronto). More commonly, fibre or metal drums are placed under each opening to catch material as it is deposited. A collection truck carrying a load of empty drums must then be sent out to replace full ones at the various depots.

Construction costs for stationary depots can be minimized by salvaging waste materials where possible, but where they are to be placed in public areas (such as retail locations or school

grounds) emphasis must be placed on appearance and safety.

This has generally required the use of professional contractors, and construction costs can vary from \$750 to \$2,000 per depot, depending on depot size and number of compartments.

The primary limitation of this design type is the difficulty of handling the full drums. While newspapers are usually unloaded by hand into the collection truck, and ferrous cans are seldom flattened to a degree that weight is a problem (full barrel weighs approximately 50 - 60 lbs), handling glass in this manner requires care. A full 45 gallon drum of glass dropped into the depot may weigh from 100 lbs. to 150 lbs. Two persons are generally required to lift the drum safely. Some operators have eased safety concerns by using wheeled carts and barrel handlers, and by using hydraulic tailgates on the collection vehicles.

Perhaps the best advantage to this approach is that a special collection vehicle is not required to service the depot, and as such it has been the most common approach in this province.

Users:

City of Toronto (TRAC) - Rob Sinclair (416) 392-7850
Niagara Recycling – Brian McMullan (416) 892-5721
Durham Recycling – Glenda Gies (416) 597-5264
Halton Recycling – Gwen Discepolo (416) 335-2193
Total Recycling (Kitchener) – Doug Ludolph (519) 744-8130

Self-Dumping Depots

A response to the inherent handling problems of small unmanned depots has been the development of depot designs which allow for self-dumping. Basically, the depot itself is designed so that it can be mechanically lifted and its contents off-loaded directly into the collection vehicle. The primary impetus for this design has been the development of recovery systems for waste glass in European and some U.S. cities, where a dense network of depot sites can be serviced economically. The key limitation of this approach is that a special collection vehicle is required with a hydraulic crane and appropriate storage compartments for each type of material handled.

A commercially available self-dumping depot is the "igloo" system, originally developed in Europe. The igloo shaped, fiberglass reinforced, polyester depots have two steel eyelets at the top and steel trap doors on the bottom. Each igloo is approximately five feet high with a capacity of three cubic yards and handles a single material. The depots are best serviced by a roll-off truck fitted with a hydraulic crane. The

crane picks up the depot by the steel eyelets, the contents are emptied into the roll-off container by releasing the trap door and the empty depot is then returned to the ground. If handling more than one material, the roll-off container can be divided into sections. The truck can hydraulically unload the collected material at the processing facility.

The number of depots that can be serviced by one truck depends on the variety of materials handled, the distance between sites, and the frequency of collection. As a point of reference, the California Glass Recycling Corporation has 900 igloo depots installed in Southern California for recycling glass only. The depots are serviced by Ecolo-Haul Ltd. of Santa Monica, using six collection trucks (150 depots per truck).

Individual depots cost approximately \$700 each and a roll-off truck fitted with a crane arm costs \$90,000 - 100,000.

The advantages to the igloo system are:

- several depots can be emptied by one truck and one operator without having to transport the depots;
- the igloos are attractive and can be located in public areas.

The igloo system is well suited for high-rise neighbourhoods, institutions, factories, retail and recreational areas.

*Self-Dumping
Depot Manufacturers*

Kotrac Milieu B.V.
Zwingstraat 1
3053 JT Rotterdam
The Netherlands
Telex: 26246 Kotra n1
Telephone: (10) 22 03 11
Contact: J. Kraak Vice – Consul (Commercial)
Consulate General of the Netherlands
1 Dundas St. West, Suite 2106
Toronto, Ontario M5G 1Z3
(416) 598-2520

Recycling Technology Specialists (RTS)
6565 Smith Ave.
Newark, California 94560
(415) 791-6980
Gary Peterson

Users:

California Glass Recycling Corporation - George Henebury
(415) 989-0536.

Roll-Off Containers

This depot is made from a standard 40 cubic yard roll-off container, modified by dividing it into separate compartments for glass, cans and newspaper. Small holes are cut in the tops for glass and cans and doors cut in the side for newspaper. The dividers are hinged to allow materials to be hydraulically unloaded, one at a time.

When the container is full, it is winched onto a roll-off truck and taken to the processing facility. Obviously, one additional roll-off is required as a float in the system.

The cost of a standard roll-off container is approximately \$3,000. Modifying for multi-material collection will raise the price to approximately \$7,000. The truck required to service the roll-offs is \$75,000 - 80,000. Capital expenditures can be reduced by contracting with existing waste haulers to undertake the collection function. The advantages to this system are:

- the depot is of sufficient size that less frequent servicing is possible.
- separate collection is not required for different materials.

This type of system is best suited for rural areas where infrequent servicing is desirable. Given that the siting of a depot will often require a concrete or asphalt pad and a large area for the collection vehicle, it is generally not a suitable option for high-rise complexes or small commercial/retail sites.

User: Total Recycling (Kitchener) – Doug Ludolph (519) 744-8130.

Portable Collection Bins

These depots are often constructed from standard 2 or 3 cubic yard steel waste collection bins with wheels and channels underneath (for service by forklift), or on the sides (for service by front-end loaders). A separate bin is required for each material being recovered. Openings are cut in the

hinged top to allow participants to deposit their materials. The bins can be emptied by a front-end loader at the depot site or they can be carried back to a processing facility by a specially designed trailer with hydraulic forks. If a front-end loader is used, separate collection runs must be made for each material. With the trailer system, frequent trips must be made back to the processing facility.

A trailer system consists of a van or truck and a trailer with three to six sets of hydraulic forks for carrying bins. Empty bins are lowered hydraulically off the trailer to replace the full bins, which are then lifted onto the trailer to be transported to the collection facility. Estimated costs for a complete trailer system with truck is \$60,000 - 80,000. Individual bins cost \$500 to \$600 each.

A portable collection bin system may be best suited for high-rise neighbourhoods. The system is used (with trailers) in Santa Monica, California and Palo Alto, California. For further information on trailers see Section II. B.1.

Users:

Santa Monica, CA – Deborah Baine (213) 458-8526

Palo Alto, CA – Vera Dahle (415) 329-2495

B. CURBSIDE COLLECTION

Experience has shown that an effectively designed Class I curbside collection program can significantly increase the volumes of recyclables recovered from the residential waste stream.

Curbside programs which have achieved the highest material recovery rates in Ontario are those where:

- collection of recyclables occurs once a week and coincides with regular garbage collection,
- material separation and preparation is made as simple and convenient as possible for the householder,
- the program is properly advertised and promoted not only at the start up, but on a regular, ongoing basis.

Perhaps the two key elements in such a program, however, are the use of household recycling containers and specialized collection vehicles.

1. HOUSEHOLD RECYCLING CONTAINERS

The use of household containers in multi-material curbside collection programs has grown tremendously in the past few years, with good reason. Participation rates and quantities of material collected (particularly for food and beverage containers) have increased dramatically in Ontario recycling programs where containers have been introduced.

Containers provide convenient storage of separated materials in the home and facilitate setting the materials out at the curbside. In the home, the container is a constant reminder to the householder about the program, while at the curbside it creates gentle peer pressure for non-participating neighbours. The container also improves collection efficiencies by being highly visible and easy to service.

The most prevalent container in Ontario is a rectangular box made from medium or high density polyethylene. Recyclables are co-mingled in the container by householders, although some models can be fitted with dividers for segregating materials.

Other types of containers used in the United States include plastic buckets and two or three tier stacking boxes. With these systems separated materials are placed in each container by the householder. Some programs also distribute re-usable plastic or mesh bags.

Co-mingling recyclables in a single container has the following advantages:

- minimizes material preparation by participants.
- single container takes up less space in the home and is easier to carry to the curb than multiple containers.
- more valuable recyclables are interspersed with less valuable material to minimize scavenging.
- accomodates changes in individual material volumes.

There are several product design criteria which should be considered when purchasing containers for a curbside program:

- container size, weight and volume capacity needs to be large enough to handle several materials yet small and light enough for a householder to carry to the curb.
- handle design should be safe, comfortable and easy to grasp.
- drainage holes - container should allow for some liquid accumulation during in-house use, but permit rain water drainage while outside.
- durability - able to withstand temperature extremes, rough handling, household chemicals.
- nesting capability - for storage and shipment efficiency.

A comparison of containers on the market is shown on Table 1.

*Household Container
Manufacturers*

A-1 Products Corp
Box 61
Etobicoke, ont M9C 4V2
(416) 626-6446
Don Holliday

User: Total Recycling (Mississauga) - Nyle Ludolph (416)
624-8353

Allibert Industries Ltd.
300 Canal Bank Rd.
Suite 304
Montreal, Quebec H8R 1H3
(416) 783-8345
Ed Casey

Buckhorn Material Handling Products
7512 Bath Road
Mississauga, ont L4T 1L2
(416) 678-6545
Ray Gargarella

User: Total Recycling (Kitchener) Doug Ludolph (519)
744-8130

2. COLLECTION VEHICLES

During the last decade a number of specialized recycling trucks and trailers have been designed to improve collection efficiency and to minimize unloading time at the processing location. Many operators continue to adapt pick-up trucks, cube vans, rear loading packer trucks and trailers to meet the requirements of their programs. Increasingly, however,

TABLE 1
HOUSEHOLD RECYCLING CONTAINERS

<u>Manufacturer</u>	<u>Type</u>	<u>Weight</u>	<u>Dimensions</u>	<u>Volume</u>	<u>Capacity</u>
Allibert	¹ HDPE Box	4 lbs	19.7" x 15.75" x 11.81"	1.5 cu. ft.	85 lbs.
A-1 Products Corp.	² MDPE Box	4 lbs.	20" x 16" x 12"	1.5 cu. ft.	80 lbs.
Buckhorn	HDPE Box	4 3/8 lbs.	20" x 16" x 12"	1.5 cu. ft.	50 lbs.

1. high density polyethelene
2. medium density polyethelene

high volume curbside programs use vehicles specifically designed for recycling.

There are three basic types of specialized vehicles currently available - closed body trucks, open top trucks and trailers. The specifications for these vehicles are standardized to a large extent. When purchasing a truck, operators should ensure that it comes equipped with:

- a block heater for winter operation
- dual steering to permit one man operation
- high quality tires.

Closed Body Collection Trucks

This unit consists of an enclosed compartmentalized body installed on a lowered truck chassis, and a low entry walk-in cab with dual left and right hand driving controls. This configuration allows the driver to also load materials, thereby eliminating the need for an extra worker.

The body is a steel structure with a solid roof and movable dividers to create from two to four compartments for different materials. One side is open for manual loading by the driver. Light weight removable side panels contain the load as the level of the materials rises. The overall capacity of the truck can be 27 to 29 cu. yds. The truck is equipped with a front mounted telescopic hoist and rear body hinge for dumping. Each compartment is discharged separately by

opening the rear door, unlocking the appropriate compartment divider, and tipping the body. The price range for this vehicle is \$55,000 - 65,000.

*Closed Body Collection
Truck Manufacturers*

Amertek Inc. (Belgium Standard)
873 Devenshire Avenue
P.O. Box 865
Woodstock, Ontario N4S 8A3
(519) 539-7475
Larry Muter

User: Total Recycling (Kitchener), Doug Ludolph (519)
744-8130

AMI Steego (Recycle King)
2520 Haines Road
Mississauga, Ontario L4Y 1Y6
David Murray

User: Total Recycling (Mississauga), Nyle Ludolph (416)
624-8353

Jaeger Canada Equipment Ltd. (Pelican)
43 Gaylord Rd.
St. Thomas, Ontario N5P 3S1
(519) 631-5100
Tom Earl

Open Top Collection Trucks

Several curbside programs in the United States use a specially designed vehicle with two or three open top self-dumping hydraulic bins. The front bins are 4 to 5 cu. yards and can be specified to unload left or right. The back bin, which dumps to the rear has a capacity of 8 to 9 cu. yds.

The cab can be designed for right hand stand up drive to allow the loading function to be performed by the driver. The individual hydraulic bins are easier to unload than the single unit, but are also less flexible because bin capacity is fixed.

Prices for this vehicle can range from \$80,000 to \$110,000.

Open Top Collection Truck Manufacturers

Able Body Co.
P.O. Box 891
Newark, CA 94560
(415) 796-5611
Ed Kouri

User: Marin County, CA, Joe Garbarino (415) 453-1404

Lodal Inc.
P.O. Box 2315
Kingsford, Michigan 49801
(906) 779-1700
Robert Carlson

User: Davis, CA, Amy Ellis (916) 756-4646

Peerless
18205 S.W. Boones Ferry Road
P.O. Box 447
Tualatin, Oregon 97062
(503) 639-6131
Robert Alvis

User: New York Office of Resource Recovery, Joan
Edwards (212) 566-0922

Trailers

There are two basic designs for recycling collection trailers. The first type is a single open top container that can be segmented into five compartments with adjustable hinged dividers. The compartments can be hydraulically unloaded to the rear in the same manner as the closed body truck. This trailer is commonly used in curbside programs, pulled behind a pick-up truck or conventional garbage packer truck. The use of the recycling trailer behind a garbage truck is an efficient collection system but may create safety concerns for workers having to stand between the truck and trailer to load garbage.

A gooseneck or "fifth wheel" model attached to a pick-up or flat bed truck has a smaller turning radius than trailers with a low-pull hitch, although both are less maneuverable than a single unit vehicle. The cost of an open top trailer is \$18 - 20,000.

The second type of trailer is used to transport portable collection depots. It is a steel frame with sets of hydraulic

forks for each depot bin. Trailers can be designed to handle three to six bins (one to five cu. yd. capacity) and can be low-pull or gooseneck style.

The cost for this type of trailer is \$12,000 - 16,000 with bins costing \$500 - 600 each. A 1.5 ton stake bed body truck to pull the trailer will cost \$30,000 - 40,000. An important consideration when purchasing a truck to pull the trailer is whether it has sufficient axle load capacity.

A comparison of collection vehicles is provided in Table 2.

Trailer Manufacturers

General Engines Co. Inc. (Eager Beaver curbside trailer)
Interstate 295
Thorofare, N.J. 08086
(609) 845-4500
Rose Rowan

User: Borough of Haddonfield, N.J., Richard Schwab
(609) 429-4700

Mobile Equipment Company Inc (ESY depot trailer)
3610 Gilmore Avenue
Bakersfield, CA 93308
(805) 327-8476
Gary Stanfill

User: Santa Monica, CA, Deborah Baine (213) 458-8526

TABLE 2

COLLECTION VEHICLES

<u>Manufacturer</u>	<u>Model</u>	<u>Description</u>	<u>Loading Height</u>	<u>Capacity of Container(s)</u>	<u>Overall Dimensions (L,W,H)</u>
TRAILERS:					
General Engines Co.	Recycler 6	• Single container, dividable into five compartments • Hydraulic rear dumping • All-aluminum body	54"	15 cu. yd. (6 tons)	23'11" x 8' x 6'4"
Mobile Container Company, Inc.	ESY Mobile Container System	• 3 - 6 containers • Hydraulic forks for picking up and dropping off containers	54"	2-3 cu. yd.	16' x 8' x 5'6" (3-bin) 33'3" x 8' x 6'4" (6-bin)
TRUCKS:					
Able Body	CRV	• 3 open-top bins with side and rear hydraulic unloading	62"	variable	Variable
Amertek	Belgium Standard	• Single unit body with hinged dividers • Open on one side for loading • Hydraulic rear unloading	57"	29 cu. yds. (6.5 tons)	25'6" x 8' x 9'9"
AMI Steego	Recycle King I	• Single unit body with hinged dividers • Side loading • Hydraulic rear unloading	57"	29 cu. yd. (7 tons)	25'6" x 8' 9'9"
LoDal	ECO 3000	• 3 open-top bins with side and rear hydraulic unloading	60" - 70"	two 4 cu. yd. one 8 cu. yd.	31'10" x 8" x 9'6"

TABLE 2

COLLECTION VEHICLES (cont'd)

<u>Manufacturer</u>	<u>Model</u>	<u>Description</u>	<u>Loading Height</u>	<u>Capacity of Container(s)</u>	<u>Overall Dimensions (L, W, H)</u>
Peerless	Curbside Recycling Vehicle	• 2 open-top bins with side and rear hydraulic dumping (3 bin model also available)	40" - 56"	one 5 cu. yd. one 7 cu. yd.	27'11" x 8' x 4'8"
Jaeger	Pelican	• Single unit body with hinged dividers • Side loading • Hydraulic rear unloading	57"	27 cu. yd. (6 tons)	25'9" x 8' x 9'9"

III. PROCESSING TECHNOLOGIES

This section of the manual evaluates the range of technological options available for processing newspaper, steel, aluminum, glass and PET. Peripheral equipment required at a processing facility (such as conveyors, forklifts, and skid steers) is also evaluated.

The overall design of a processing facility, while outside the scope of this manual, has a major influence on equipment selection. Design of material process streams must take into account the following factors:

- type and volumes of materials collected
- degree of sorting at the curbside vs. at the central facility
- material end market specifications and transportation methods.

The process design should be flexible enough to accommodate changes in end market requirements and addition of new materials in the future.

The layout of the facility must provide adequate space for receiving, processing, storing and shipping material.

Additional storage space should be provided to allow for material accumulation during processing equipment shutdowns.

The interior floor of the facility should be a concrete surface while the yard should be paved and provide sufficient space for truck traffic flow (unloading, weighing, parking) and possible material storage.

If possible, an existing building should be utilized, although this is often restricted by door access and ceiling height limitations. New building design will be governed by space requirements and local by-laws.

A. BALERS

Balers compress material into dense rectangular bales in order to facilitate handling and maximize storage and shipping efficiencies.

Recycling programs in Ontario have traditionally used balers to process newspapers, old corrugated cartons (O.C.C.) and fine paper. Newspaper may also be accepted loose by end markets, which eliminates the need for baling. Shipping newspaper loose is often cost effective for small recycling operations located close to an end market or an intermediate processor.

PET bottles and metal cans may also be baled in Ontario. Choosing the proper baler for an operation will depend on what materials are going to be baled and in what volumes.

The three basic types of balers - upstroke vertical, downstroke vertical, and horizontal - are described below.

Upstroke Balers

An upstroke baler is installed in a 10 to 12 foot deep steel-lined pit and the bottom platform or platen is pulled upward

mechanically, to compress the material in the baling chamber. A key advantage of an upstroke baler is that material is loaded at floor level and can simply be pushed, either mechanically or by hand, into the baling chamber. Several loadings may be required to complete the bale and finished bales must be strapped or tied manually. Upstroke balers are very durable, and have low maintenance costs. They are most often used to bale newspaper, O.C.C. and fine paper. Bales are typically 600 - 1000 lbs. each and throughput may be as high as two tons per hour.

Upstroke balers range in price from \$25,000 to \$35,000. The installation of a pit can cost an additional \$10,000 - \$30,000 depending on various considerations such as height of the local water table. The pit will also require regular cleaning to remove debris that falls between the platen and the sides during the loading of the chamber. A radius of six to nine feet on both sides of the baler is needed as permanent clearance for each door.

User: Scott's Plains Recycling, Peterborough - Reg Forth
(705) 876-1600

Downstroke Balers

In a downstroke baler, the hydraulically powered ram moves downward, compressing material into the baling chamber and returns to the top position which reopens the chamber

for another loading. Like the upstroke baler, several loadings may be needed to make one bale. The infeed opening of a downstroke baler is above the bale chamber which means that material must be lifted either mechanically or manually. Finished bales must be manually tied by the operator.

To be installed, downstroke balers require a concrete base only, so they are less expensive to install than upstroke balers and can be moved to a new location. They are most commonly used to bale OCC and newsprint although certain heavy duty models can handle PET and metals. Paper bale weights are typically 500 - 1000 lbs. and the capacity may range from 300 lbs. to 1 ton per hour. Downstroke baler prices range from \$10,000 to \$30,000.

User: Durham Recycling - Glenda Gies (416) 579-5264

Horizontal Balers

Horizontal balers are high production machines which can often bale a variety of material including metal and PET. Material is loaded into a hopper on top of the baler, usually by conveyor. The ram and platen move horizontally to compress the bale. Some models have a second ram which either pre-packs the material or ejects the bale. Horizontal balers can have a closed chamber or be open-ended. An open-ended baler allows for automatic ejection without

manual intervention. High end models have automatic bale density controls and bale tying systems which further reduce labour requirements.

Bale weights for paper can range between 1000 and 2000 lbs. and production capacity varies from 1 ton to 15 tons/hr. Horizontal balers must be installed on a flat, reinforced concrete pad. Small manual-tie balers range in price from \$25,000 to \$50,000, and a large fully automatic baler can cost between \$150,000 and \$300,000.

User: Total Recycling - (Mississauga) - Nyle Ludolph (416) 624-8353

There are several factors which must be considered when selecting a baler:

- types of materials which can be baled.
- volume throughput for each material type.
- bale size - important for transportation efficiency.
- labour requirements - horizontal balers generally require less manpower to operate than vertical balers.
- installation requirements - upstroke balers require a pit whereas downstroke and horizontal bales require a concrete base only. A horizontal baler takes up more floor space than a vertical baler and requires a conveyor to feed the hopper.
- operating and maintenance costs.

- power requirements.
- safety features.

In general, vertical balers are suitable for small recycling operations (less than 1000 tons of material per year). A downstroke may be more cost efficient than an upstroke because of lower purchase and installation costs. Larger size operations should consider an automated horizontal baler. The higher purchase price is offset by the increased production capacity and reduced labour requirements.

A baler which can process a variety of materials is usually preferable to one which is limited to one or two materials. The decision to bale certain materials or to process them by other methods will depend on relative volumes, and comparative capital and labour costs. Buyers of the material should be closely consulted in this decision (see Appendix A for contacts).

Before speaking with baler manufacturers, operators should first determine what materials are going to be baled and the approximate volumes of each; this will enable the manufacturer to recommend a specific type and model.

Table 3 provides a comparison of selected baler types and models.

Baler Manufacturers

Ambaco/Economy
Dist: Wm. M. Bennett & Associates
90 Midland Ave.
Scarborough, Ont. M1N 4A2
(416) 261-3280
William Bennett

Balemaster/Balewel
Dist: Eakins Inc.
2660 Sabourin St.
St. Laurent, Que. H4S 1M2
(800) 363-0704
Brian Street

Enterprise Co.
616 So. Santa Fe
Santa Ana, CA 92705
(714) 835-0541
John Kossakoski

Falcon Equipment Co.
16228 S. Figueroa St.
Gardena, CA 90248
(213) 327-4880
(213) 770-6088
Randy Conner

HRB
Dist: Amaco Construction Equipment Inc.
5804 Datsun Rd.
Mississauga, Ont. L4W 1H2
(416) 671-3440
Bruce Garnet

International Baler Corp.
P.O. Box 6922
Jacksonville, FL 32236
(904) 358-3812
Frank P. Lederer

Kargo
Ajax Material Handling Ltd.
566-570 Finley Ave.
Ajax, Ont. L1S 2E3
(416) 683-9501
John Hansen

Kilkom Inc.
Industrial Park Bldg. 13
Spokane, WA 99216
(905) 828-5252
Skip Hissong

Logemann Brothers Co.
3150 West Burleigh St.
Milwaukee, WI 53210
(414) 445-2700
Bob Pichta

Marin Engineering Corp.
Dist: Kernic Equipment Sales
955 Century Drive
Burlington, Ont. L7L 5J8
(416) 632-0562
Derek Simons

TABLE 3
BALERS

<u>Make</u>	<u>Type</u>	<u>Models</u>	<u>Description</u>	<u>Materials Processed</u>	<u>Estimated Maximum Capacity</u>
Ambaco	Horizontal	NSB 350	High density 2 Ram auto-tie open-ended	Newspaper OCC	22 tons/hr. 14 tons/hr.
			High density Auto-tie Open-ended	Aluminum	3 tons/hr.
	Horizontal	10567	High density Manual tie Closed Chamber	Aluminum Steel	2 2/3 tons/hr. 1 1/4 tons/hr.
Economy	Horizontal	54 AHD-36	Medium Density	Newspaper OCC	3/4 ton/hr.
			High Density Can Baler	Aluminum Steel	1 1/2 ton/hr.
	Downstroke	60 HD	Medium Density	Newspaper OCC	1 ton/hr.
Balemaster	Horizontal	E series	High Density Auto tie Open End Bale Density Control	Newspaper OCC Aluminum Steel PET	7 tons/hr. 5 tons/hr. 4 tons/hr.
			High Density Manual Tie Closed Chamber	Newspaper OCC Aluminum Steel PET	1400 lbs./hr.
	Horizontal	1800			

1. Selected models only. Contact manufacturers for complete product lines.
2. Baler may handle additional materials.
3. Actual capacity will depend on material preparation and loading method.

TABLE 3
BALERS (Cont'd)

<u>Make</u>	<u>Type</u>	<u>Models</u> ¹	<u>Description</u>	<u>Materials Processed</u> ²	<u>Estimated Maximum Capacity</u> ³
Enterprise	Downstroke	3054	High Density	Aluminum Steel OCC Newspaper PET	2 tons/hr. 4 tons/hr. 3 1/2 tons/hr. 4 tons/hr.
Falcon	Downstroke	FVB-2954	High Density	Aluminum Steel OCC Newspaper PET	1.5 tons/hr. 1 ton/hr. 1.5 tons/hr.
HRB	Horizontal	FHB-6040	High Density Manual Tie Open End	Aluminum, Steel OCC Newspaper PET	6 tons/hr.
HRB	Horizontal	HRB-2A	High Density 2 Ram auto tie Open End	Aluminum Steel OCC Newspaper PET	3 - 4 tons/hr. 5 - 6 tons/hr. 6 - 8 tons/hr.
	Horizontal	HRB-8	High Density 2 Ram auto tie Open End	Aluminum Steel OCC Newspaper PET	8 - 9 tons/hr. 10 - 12 tons/hr. 14 - 18 tons/hr.
International	Horizontal	NA 1440	High Density Closed Chamber PET Baler	Aluminum Steel OCC Newspaper PET	Contact Manufacturer

1. Selected models only. Contact manufacturers for complete product lines.
2. Baler may handle additional materials.
3. Actual capacity will depend on material preparation and loading method.

TABLE 3
BALERS (Cont'd)

<u>Make</u>	<u>Type</u>	<u>1</u> <u>Models</u>	<u>Description</u>	<u>2</u> <u>Materials Processed</u>	<u>3</u> <u>Estimated Maximum Capacity</u>
Kargo	Downstroke		Medium Density	Aluminum OCC Newspaper	Contact Manufacturer
Kilkom	Downstroke	KXD-60	High Density	Newspaper OCC Aluminum	3/4 tons/hr. 1/5 tons/hr. 1/2 ton/hr.
	Horizontal	CWK-12	High Density 2 Ram auto tie Open End	Newspaper OCC Aluminum PET	8 tons/hr. 5 tons/hr. 2 tons/hr.
Logemann	Horizontal	245A-AT	High Density 2 Ram auto tie Open End	Newspaper OCC PET	16 - 22 tons/hr.
Marin	Horizontal	122	High Density Closed Chamber	Newspaper OCC Aluminum PET	Contact Manufacturer

1. Selected types and models only. Contact manufacturers for complete product lines.
2. Baler may handle additional materials.
3. Actual capacity will depend on material preparation and loading method.

B. CAN PROCESSING EQUIPMENT

Can processing generally involves two stages - magnetic separation and volume reduction. Separation is currently not required in Ontario because aluminum soft drink cans are not yet on the market and steel mills can tolerate the small amounts of aluminum included in recycled steel can shipments. As of September 1987, aluminum will be allowed in the Ontario market. In areas where aluminum and steel cans are collected together, a magnetic separation process will be necessary.

Volume reduction can be done by four different processes - shredding, flattening, baling or densifying. Shredding is not favoured by most end-users in the Ontario region. Generally, steel cans are flattened and shipped loose to end markets, whereas aluminum is baled or densified. Both metals, however, can be processed by any of the three methods. Operators are advised to consult with end users prior to deciding which processing method to use (see Appendix A).

Magnetic Separators

Magnetic separators can be purchased as a stand alone unit or as a component of a flattener or densifier. A separator unit usually consists of a feed hopper, conveyor and a magnetic head pulley which diverts steel cans down to another conveyor or a storage container, while the aluminum cans continue off the end of the conveyor. A separator unit can cost from \$2,500 to \$5,000. A magnetic head pulley as an option on an infeed conveyor costs \$250 - \$350.

Flatteners

Flattening can be done with automated flatteners or by less conventional methods such as running over the cans with a track type front-end loader. The second method is only suitable for steel can processing, which can accommodate aluminum and other contaminants.

Automated flatteners compress the cans between two rotating drums, or one drum and a fixed plate, to a density of 6 - 12 lb. per cubic foot. Can flatteners are usually designed to handle either aluminum or steel. When purchasing a flattener to process steel cans an important consideration is whether it can handle large 48 oz. juice cans or other large containers. It is recommended that operators ask the manufacturer or distributor for a demonstration before buying to ensure the equipment can process all sizes of steel cans.

Can flatteners normally consist of an infeed hopper and conveyor, a flattening mechanism and a discharge blower tube. Prices range from \$10,000 to \$12,000.

Balers

Can baling can be done in certain heavy duty downstroke balers and in horizontal balers. Baling achieves higher densities than flattening and allows for easier material handling. Densities and weights for a sample bale with the dimensions 30" x 40" x 54" are shown below:

Aluminum: Density - 16-18 lb. per cubic foot
 Weight - 600-700 lbs.

Steel: Density - 25-30 lb. per cubic foot
 Weight - 800-1100 lbs.

When purchasing a baler to bale metal cans operators should ensure that it comes with an abrasion resistant platen and side rails. Horizontal balers should have at least 100,000 lbs. of thrust and an 8 inch ram cylinder.

For technical information on specific baler types refer to Section III.A.

Densifiers

Can densifiers hydraulically compress cans into small highly compact cubes or biscuits which are more efficient to transport than bales. Densifiers are commonly used for processing aluminum cans, but can also handle steel cans. For a sample biscuit with the dimensions 8" x 10" x 11" densities and weights are as follows:

Aluminum: Density - 35-45 lbs. per cu. foot
 Weight - 18-20 lbs.

Steel: Density - 60-65 lbs. per cu. foot
 Weight - 30s.-35 lbs.

Can densifiers come equipped with a feed hopper and magnetic separator. Prices range from \$20,000 (500 lb/hour capacity) to \$40,000 (2,000 lbs./hour capacity).

A comparison of various types of can processing equipment is provided in Table 4.

Can Processing Equipment Manufacturers

CP Manufacturing Inc. (separators, flatteners, densifiers)
1428 McKinley Avenue
National City, CA 92050
(619) 477-3175
John Willis

Dens-A-Can International (densifiers)
P.O. Box 11403
Pittsburg, PA 15238
(412) 963-6660
Richard J. White

Galland Henning Nopak Inc. (densifiers)
1025 South 40th St.
Milwaukee, WI 53215
(414) 654-6000
John Fuchs

Miller Manufacturing Co. (separators, flatteners)
P.O. Box 336
Turlock, CA
95381
(209) 632-3846
Richard Veeck

Mosley Machinery Co. (densifiers)
P.O. Box 1552
Waco, TX 76703
(817) 799-2491
Roger Hoffman

Recycling Equipment Manufacturing (separators, flatteners)
Distributor: Bruce Mooney Associates Inc.
1849 Fairhill Road
Allison Park, PN 15101
(412) 367-2686
Bruce Mooney

Shred-Pax Ltd. (flatteners, densifiers)
201 Beverley St.
P.O. Box 208
Cambridge, Ont. N1R 7G8
(519) 621-3560
John Bell

Prodeva Inc. (flatteners)
Distributor: Kervic Equipment Ltd.
955 Century Drive
Burlington, Ont. L7L 5J8
(416) 632-0562
Derek Simons

TABLE 4

CAN PROCESSING EQUIPMENT

Flatteners	<u>Model</u>	<u>Capacity (material)</u>	<u>Hopper</u>	<u>Processing Horsepower</u>	<u>Weight</u>	<u>Dimensions (H x W x L)</u>
R.E.M.	CC5	1100-1400 lbs./hr. (alum)	1/3 cu. yd.	5	1300 lbs.	7' x 4' x 12'
	CC7 1/2	1600-2200 lbs./hr. (alum)	1/3 cu. yd.	7 1/2	1300 lbs.	7' x 4' x 12'
	Food Can Crusher	2000 lbs./hr. (steel)	1/3 cu. yd.	10	1500 lbs.	7' x 3' x 12'
Miller Manufacturing	MM 2500 CF 2424	1 - 1/2 tons/hr. (alum) 1 ton/hr. (steel)	3/4 cu. yd. 3/4 cu. yd.	7 1/2 7 1/2	3170 lbs. 2000 lbs.	7'5" x 5'6" x 14'9"
CP Manufacturing	CP250	2500 lbs./hr. (alum)	3/4 cu. yd.	7 1/2	2000 lbs.	6' x 3' x 12'
Shred-Pax	Can Flattener	N/A (steel & aluminum)	1 cu. yd.	5	1200 lbs.	7'6" x 4' x 7'6"
Prodeva	250	N/A (steel & aluminum)	1/9 cu. yd.	5	1736 lbs.	5' x 3'2" x 6'8"
Separators						
R.E.M.	MS8 MS 16	1500 lbs./hr. 1500 lbs./hr.	1/3 cu. yd. 1/3 cu. yd.	1/4 1/2	510 lbs. 790 lbs.	4'6" x 4' x 10' 6' x 4' x 20'
Miller Manufacturing	SS2250 SS6000	2500-4000 lbs./hr. 4000-10,000 lbs./hr.	3/4 cu.yd. 3 cu. yd	1/2 2	900 lbs. 2000 lbs.	
CP Manufacturing	CC6 CC8	3000 lbs./hr. 6000 lbs./hr.	1/4 cu. yd. 1/2 cu. yd.	1/6 1/2	400 lbs. 650 lbs.	6' x 3'4" x 6' 6'7" x 4'6" x 11'

TABLE 4

CAN PROCESSING EQUIPMENT (cont'd)

Densifiers	<u>Model</u>	<u>Capacity</u> (aluminum)	<u>Hopper</u>	<u>Processing</u> <u>Horsepower</u>	<u>Weight</u>	<u>Dimensions</u> (H x W x L)
CP Manufacturing	CD500	500 lbs./hr	1/3 cu. yd. 2 cu. yd. option	5	2000 lbs.	6'10" x 2'4" x 8'
	CD1000	1000 lbs./hr.	1/3 cu. yd.	10	2600 lbs.	6'10" x 2'6" x 8'
Mosley Machinery	RS-2000 RS-2500	2300 lbs./hr. 2500 lbs./hr.	1 cu. yd. 1 cu. yd.	15 15	4600 lbs. 4700 lbs.	8'6" x 7'6" x 8'1"
Galland Henning NoPak Inc.	PAC 20-25	1000-1200 lbs./hr.	N/A	20	5300 lbs.	9'7" x 6'8" x 9'0"
Dens-A-Can	300 500 1000	300 lbs./hr. 500 lbs./hr. 1000 lbs./hr.	1 cu. yd. 1 cu. yd. 1/3 cu. yd.	3 7 1/2 20	2200 lbs. 2500 lbs. 5200 lbs.	7'4" x 3'9" x 11' 7'4" x 3'9" x 11' 10'9" x 5' x 11'
Shred Pax	1500 3000	700 lbs./hr. 2200 lbs./hr..	1/2 cu. yd. 1 cu. yd.	7 1/2 20	3500 lbs. 8500 lbs.	8'8" x 3'10" x 10' 9'10" x 11' x 12'

C. GLASS PROCESSING EQUIPMENT

Recovered glass can be shipped back to glass manufacturers in one of three forms (densities in brackets):

- crushed cullet: (90-95 lbs./cu. foot)
- broken: (50-60 lbs./cu. foot)
- whole containers: (30-35 lbs./cu. foot)

Crushed cullet provides the highest density for transportation. However, if a recycler is going to crush, certain quality specifications must be met: 1) no ceramics contamination, 2) protection from moisture during winter, 3) metal closures must not be mutilated or broken.

Glass Crushers

There are several types of glass crushers available:

- 1) Rotary impact - a rotor catches the feed and hurls it against two impact arms or aprons. This produces a high quality cullet.
- 2) Chain flailer - the glass drops through a chute with a rotating chain. The chain breaks the glass directly or hurls it against the sides of the chute.
- 3) Rotating blades - similar to the chain flailer type except it uses 2 to 4 rotating blades instead of a chain.
- 4) Rotor and striker plate - the glass is crushed between the rotor and the plate.

The rotary impact type crushers are relatively expensive (\$25,000 - \$60,000 per installation) and are probably only suitable for large processing centres. The other types all cost in the \$4,000-\$5,000 range, complete with feed hopper and conveyor. The one exception is the Glasmaster Jr. by Count Company which can cost between \$15,000 and \$30,000, depending on the options. It can be designed with a three directional discharge for colour sorted glass.

An operator considering the purchase of a glass crusher should first consult with the glass company that will be buying the cullet to determine the most appropriate equipment (see Appendix A). Table 5 provides details on selected crusher models.

If a recycling operation cannot meet cullet specifications or cannot cost justify the investment in a crusher, it can ship uncrushed glass directly to the glass companies. Density can be increased by breaking the glass into large pieces, which can be achieved through normal handling (loading and unloading). Shipments must be free of all ceramic contamination. Recycled glass, in any form, is usually shipped loose in 40 yd. containers.

Glass companies will pay a premium for colour sorted glass. Sorting must be done manually either at the point of

collection or at the processing facility. An operator considering colour sorting should first analyze the incremental collection and processing costs in relation to the increased revenue.

Glass Crusher Manufacturers Hazemag (Canada) Ltd.(rotary impact type)
P.O. Box 439
10243 Keele St.
Maple, Ont. L0J 1E0
(416) 832-1711
Randy Fridulin

CP Manufacturing (chain flailer type)
1428 McKinley Avenue
National City, CA 92050
(619) 477-3175
John Willis

Miller Manufacturing (rotor and striker plate)
P.O. Box 336
Turlock, CA 95381
(209) 632-3846
Richard Veek

Dens-A-Can/R.E.M. (rotor and striker plate; rotating blade)
Distributor: Bruce Mooney Associates Inc.
1849 Fairhill Rd.
Allison Park, PN 15101
(412) 367-2686
Bruce Mooney

Count Company (rotor and striker plate)
Distributor: Eakins Inc.
2660 Sabourn St.
St. Laurent, Que. H4S 1M2
(800) 363-0704
Brian Street

TABLE 5
GLASS CRUSHERS

<u>Make</u>	<u>Model</u>	<u>Capacity</u>	<u>Type</u>	<u>Hopper</u>	<u>Processing Horsepower</u>	<u>Weight</u>	<u>Dimensions</u>
Hazamag	APS - 0604	10 - 15 tons/hr.	Rotary Impact	not included	5 - 12	3700 lbs.	4'5" x 4'1" x 5'0"
Dens-A-Can/R.E.M.	I	3-4 tons/hr.	Rotor & Plate	1/3 cu. yd.	1	900 lbs.	7'8" x 4' x 11'
	II	3-4 tons/hr.	Rotary Blades	1/3 cu. yd.	1	900 lbs.	7'8" x 4' x 11'
Miller Manufacturing	GB1000	1-3 tons/hr.	Rotor & Plate	3/4 cu. yd.	1	720 lbs.	7'9" x 5'8" x 9'4"
	GB0750	12 tons/hr.	Rotor & Plate	3/4 cu. yd.	7 1/2	1300 lbs.	6'2" x 6'6" x 12'
CP Manufacturing	GC100	3 1/2 tons/hr.	Chain Flailer	1/3 cu. yd.	1/2	800 lbs.	7'10" x 3'6" x 13'9"
Count Company	Glasmaster Jr.	10 tons/hr.	Rotar & Plate	1/2 cu. yd.	3	variable	10'9" x 9'3" x 15'3"

D. PET PROCESSING EQUIPMENT

PET bottles must be either baled or granulated before being shipped to end markets. For a recycling operator, baling is the most cost effective processing method because:

- the PET can be color mixed
- there are no secondary packaging costs (eg. gaylords, bags)
- the bales can be stored outside
- there is larger market for baled material
- a baler can be used to process other materials (metal, paper, OCC)

Bales are usually shipped to major processors who can break the bales apart, then colour separate and re-process the PET.

Balers

High density, closed chamber horizontal balers are best suited to handling PET. Vertical balers must be re-loaded several times during the preparation of the bale due to the memory of the material (i.e. the propensity of the bottle to return to its original shape). It is recommended that

recycling operations handling PET request householders to remove closures and flatten the bottle. This will increase storage density and decrease baling time and increase storage density on the collection vehicle.

PET perforators are available which puncture the bottles before they are fed into the baler. Perforators allow PET to be baled in low density horizontal and vertical balers, and eliminate the need to remove closures. The cost of a perforator is \$8,000-\$10,000.

A typical PET bale has a density of 12-15 lbs./cubic foot and a weight of 450-550 lbs. See Section III.A for further information on balers.

Granulators

Plastic granulators cut PET into small (approximately 3/8") pieces for extruding. The PET must be colour separated first, and stored in gaylord boxes or bags after being granulated. Granulators have a range of processing capacities. A 400 lbs./hour machine (3600 2 litre PET bottles) will cost approximately \$20,000.

Specifications for PET granulators are listed in Table 6. Operators are reminded to consult with end markets (see Appendix A) regarding processing methods.

*PET Granulator
Manufacturers*

Cumberland Engineering
P.O. Box 6065
Providence, RI 02940
(416) 283-2732
John Lalonde

Nelmor Company
Rivulet St.
North Uxbridge, MA 01538
(617) 278-5584
Tom Tomaszek

Rapid Granulator
Distributor: Mould-Tek Industries Inc.
733 Progress Ave.
Scarborough, Ont. M1H 2W7
(416) 438-6875
Ken Hoffman

Shred-Pax Ltd.
201 Beverley St.
P.O. Box 208
Cambridge, Ont. N1R 7G8
(519) 621-3560
John Bell

*PET Perforator
Manufacturers*

The Economy Baler Company (Ambaco)
Hickory St.
Bellevue, OH 44811
(419) 483-5790
John Russell

International Baler Corp.
P.O. Box 6922
Jacksonville, FL 32236
(904) 358-3812
Frank Lederer

TABLE 6
PLASTIC GRANULATORS

<u>Make</u>	<u>Model*</u>	<u>Capacity</u>	<u>Feed Opening</u>	<u>Processing Horsepower</u>	<u>Weight</u>
Cumberland	484A	700 lbs./hr.	14" x 16"	15	2400 lbs.
	584A	1000 lbs./hr.	14" x 26"	40	3100 lbs.
Nelmor	G1416M1	400 lbs./hr.	14" x 16"	15	600 lbs.
	G1820M	1200 lbs./hr.	18" x 20"	40	4000 lbs.
Rapid Granulator	1012	220-900 lbs./hr.	10" x 12"	15	1500 lbs.
	1418	6000 lbs./hr.	14" x 18"	25	2600 lbs.
Shred-Pax	1012-BP	250 lbs./hr.	10" x 12"	10	970 lbs.
	1420-BP	700 lbs./hr.	14" x 20"	25	3025 lbs.

*Selected Models only. Contact manufacturers for information on complete product lines.

E. PERIPHERAL EQUIPMENT

Recycling operations require, in addition to major processing equipment, several pieces of peripheral equipment for moving, loading, and weighing materials. Such equipment usually includes front-end loaders, forklift trucks, skid steer loaders, conveyors and weigh scales.

In this section, each of the above equipment types will be discussed. The discussion will focus on key features and issues that should be considered when purchasing for a recycling operation. Manufacturer and distributor information is also included.

1. CONVEYORS

Belt conveyors are commonly used in a recycling facility for transporting materials to and from processing equipment, for loading containers, and for hand sorting materials. As the need for centralized sorting of material expands, conveyor systems will become increasingly important.

Conveyors can be custom built for any application with various widths and positions (horizontal, inclined, angled)

and therefore a price range is difficult to provide. The key design features to consider are the belt material and the drive mechanism.

Belts can be made from rubber, steel, or plastic. Rubber belts are friction driven which means that the belt is propelled by the friction of the pulley against it. Rubber belts give good traction and are relatively inexpensive. Heavy materials can cause a friction driven belt to slip, particularly on an inclined plane.

Hinged steel belt conveyors are usually chain driven. The belt is moved by a chain on the outer edge of the belt which interlocks with sprockets on the pulley. This prevents belt slippage when handling heavy materials and permits angling of the conveyor. The chain drive also ensures that the belt tracks straight (ie. does not move from side to side). Steel belts are more expensive than rubber but are more durable.

Rigid plastic belts are sprocket driven, which means the belt interconnects directly with the sprocket. They track straight, are low friction, and are easy to repair. Plastic can compete with steel in many applications, and is often less expensive.

When choosing a conveyor system, a recycling operator should consult with several conveyor manufacturers for their assistance in designing the proper system for that specific

application. There are many conveyor manufacturers in Ontario. The following is a partial list of companies that design and build belt conveyors for bulk materials.

Conveyor Manufacturers

Great Canadian Conveyor Co.
550 Conestogo Rd.
Waterloo, Ontario
N2L 4E3
(519) 746-6950
Colin Cunningham

Mayfran Canada Ltd.
5955 Airport Rd.
Suite 200
Mississauga, Ontario
L4V 1R9
(416) 678-0018
Wayne Burley

Mosur Machine Co.
1780 Bonhill Rd.
Mississauga, Ontario
L5T 1C8
(416) 677-1404
Jim Mosur

Rapistan Systems Ltd.
56 Brockport Drive
Toronto, Ontario
M9W 5N1
(416) 675-3770
Fred Marks

Sadler Inc.
1357 Matheson Blvd.
Suite 26
Mississauga, Ontario
L4W 2A1
(416) 624-2281
Gerry Hunt

Sullivan Strong Scott Ltd.
74 Wildcart Rd.
Downsview, Ontario
M3J 2V4
(416) 661-5880
John Fitzpatrick

2. FORKLIFT TRUCKS

Forklift trucks are used by recycling operations to load baled material onto transport trucks. Important issues to consider when purchasing a forklift are:

- lifting capacity
- tire type
- energy source
- mast extension
- safety features.

Forklifts can have a rated lift capacity of 1-15 tons. A lift capacity of 2-3 tons should be sufficient for most recycling operations. Optimal capacity is dependent on the weight and load centre of the bales being lifted. For example, a 1400 lbs. newspaper bale requires a lift capacity of at least 2800 lbs.

The proper tire type to select depends on where the forklift is used. Pneumatic tires are needed for most outdoor work while cushion (solid rubber) tires are needed for most indoor work.

There is a variety of energy sources available - gasoline, diesel, propane, electric, natural gas or combination of gasoline and propane. If the lift truck is going to be used indoors it should have a power source other than gasoline. Propane is the most popular fuel for indoor machines because it is clean, efficient, and quiet. Diesel can be used indoors with an emission control system. An electric lift truck costs \$7,000-10,000 more than other types due to the extra cost of the battery and charger. Also, electric trucks will not function at capacity in cold weather (0°C and below).

Mast extension is an important feature to consider particularly for loading bales onto trailer trucks. It is important to ensure that when lifting a bale to truck level, the mast does not extend above the roof of the truck.

A rotating head attachment may be considered by an operator if the forklift is being used to lift and dump containers of loose material.

Key safety comfort features to look for are strong overhead safety screen, good operator visibility, adjustable fork lowering speeds, low noise level, accessible parking brake, and back up alarm.

The cost for propane powered, 2-3 ton capacity forklifts is in the \$20,000-25,000 range.

Forklift Manufacturers

Crothers Caterpillar
100 Fernstaff Court
Concord, Ont. L4K 2V8
(416) 738-8500
Reg Kishimoto

Clark Equipment company
Agent: J.H. Ryder Machinery Ltd.
25 Beasley Drive
Kitchener, Ont. N2E 1W7
(519) 893-6230
Dave Bristow

Drexel Industries
Agent: J.H. Thomas Industries Ltd.
2726 Slough St.
Mississauga, Ont. L4T 1G3
(416) 677-0550
John Gowland

Hyster Company
Agent: Wajax Industries Ltd.
3280 Wharton Way
Mississauga, Ont.. L4X 2C5
(416) 624-5611
Bob Parsonson

Mitsubishi Heavy Industries Ltd.
Distributor: Solar Materials Handling Ltd.
209 Wilkinson Rd.
Brampton, Ont. L6T 4M2
(416) 453-5885
Pierre Gadbois

Nissan Automobile Company (Canada) Ltd.
Distributor: Lansing Canada Inc.
1250 Steeles Ave.
Bramalea, Ont. L6T 1A1
(416) 459-5910 1-800-268-0889
Jerri-Lee Hill

Toyota Canada Inc.
Forklift Division
1291 Bellamy Rd. North
Scarborough, Ont.
(416) 438-6320
Jim McManus

Yale Industrial Trucks Ontario Ltd.
340 Hanlan Rd.
Woodbridge, Ont. L4L 3P6
(416) 745-6111
Mark McFadyen

3. SKID STEERS

A skid steer is a small front-end loader with fixed axles which is steered by locking the wheels on one side and performing a "skid" turn. It is a very useful piece of equipment for most recycling operations because it can be used to load and unload loose materials, feed materials onto conveyors or sorting tables, and, with a pallet fork attachment, lift bales onto trucks.

Performance features which should be considered when buying a skid steer are:

- operating capacity
- dump height
- engine and drive system
- hydraulics
- attachments
- safety features.

Operating lift capacity can range from 600 lbs. to 3500 lbs. A capacity of 1600-2400 lbs. should be appropriate for most recycling operations. Engine size (4 or 6 cylinder) should be considered, as well as fuel type (diesel, gas or propane). Dump height is important if the skid steer is being used to load roll-off containers. A self-leveling hydraulic bucket will make lifting and loading materials easier.

Skid steers come with a number of attachment options in addition to the standard bucket. Recycling operators may want to consider pallet forks and a grapple bucket. The ease of attachment changes should be examined in this regard.

Safety/comfort features which should be looked for are seat belt, seat bar, protective screening, parking brake, and spark arrester muffler.

Prices for 1600-2400 lbs. capacity skid steers are in the \$30,000-40,000 range. Attachments are extra.

Skid Steer Manufacturers

Melroe Company (Bobcat)
Dealer: L.W. Mathews Equipment Ltd.
140 Fenmar Drive
Weston, Ont. M9L 1M6
(416) 749- 4911
Ron Jackson

Thomas Equipment Ltd.
55 Torlake Crescent
Toronto, Ont. M8Z 1B4
(416) 252-3714
Barry Dixon

Ford Motor Company (New Holland)
Dealer: West Metro Ford Equipment Sales
195 Clairville Drive
Rexdale, Ont.
(416) 675-3660
Chris Archer

Case Power and Equipment Ltd.
11 Mars Road
Rexdale, Ont.
M9V 2K2
(416) 749-6261
Carl McKay

**4. FRONT-END
LOADERS**

Front-end loaders are used by recycling operations to pile loose metal and glass, and to load these materials into transport containers.

Key features to consider when buying a front-end loader are:

- bucket capacity
- tires vs. tracks
- engine size and make
- transmission
- hydraulic system
- steering and brakes.

The standard bucket capacity of one cubic yard should be adequate for most applications, although oversized buckets are available.

The decision to buy a front-end loader with steel tracks or rubber tires depends on the intended uses. If the loader is going to be used to flatten steel cans, steel tracks may be required. Track type loaders, however, are more difficult to maneuver and are not suitable for cement or asphalt surfaces. It is also possible to flatten cans by running over them with a wheel loader with solid rubber tires, or by compressing them with the bottom of the bucket. Heavy duty solid rubber tires should be used when handling glass.

New front-end loaders are expensive – in the \$75,000-85,000 range. For this reason, operators should carefully consider whether one is required. A skid steer with sufficient lift height may be able to perform loading functions. Also, a

processing facility can be designed so that transport containers are loaded directly off conveyors. If it is determined that a front-end loader is needed, used equipment should be considered to reduce costs.

*Front-end Loader
Manufacturers*

Crothers Caterpillar
1 Crothers Drive
P.O. Box 5511
Concord, Ont. L4K 1E2
(416) 667-5511
Norm Byrne (Used Equipment)
Alistair Commins (Recycling)

Fiat Allis
Capital Equipment Sales
2 Royalcrest Rd.
Rexdale, Ont. M9V 2L5
(416) 741-8910
Carl Nickel

Belarius Equipment of Canada
43 Goldthorne Ave.
Toronto, Ont. M8Z 5S7
(416) 259-3791
Gerry Fitzgerald

Kubota Tractor Canada Ltd.
1495 Denison Ave.
Markham, Ont. L3R 5H1
(416) 475-1090
Ms. Murphy

Massey Ferguson Industrial Equipment
6880 Cote de Liesse
Montreal, Que. H4Z 1E4
(514) 342-9037
Jerry Arnold

Motokov Canada Inc.
307 Humberline Dr.,
Rexdale, Ont. M9W 5V1
(416) 675-1710
Don Norwood

Acklinds Yanmar
1325 Lawrence Ave. East
Don Mills, Ont. M3A 1C8
1-800-387-0125
(416) 449-0541
Jim Willis

Case Power and Equipment Ltd.
11 Mars Rd.
Rexdale Ont. M9V 2K2
(416) 749-6261
Carl McKay

John Deere
P.O. Box 1000
Grimsby, Ont. L3M 4H5
(416) 945-7412
Dennis Norsworthy

Ford Motor Company
The Canadian Rd.
Oakville, Ont. L6J 5E4
(416) 845-2511 Ext. 1570
Marketing Dept.

5. SCALES

There are three kinds of scales that may be used at a recycling centre: (1) truck scales (single axle and full size) (2) floor scales and (3) bench scales.

Truck scales are platform scales which trucks drive onto for weighing. They can be either electronic or mechanical.

Electronic scales are more expensive but eliminate the need to build a concrete pit under the scale. For this reason, most new scale installations are electronic. The deck of a truck scale can be made out of steel or concrete. Steel decks generally last longer than concrete.

Truck scale lengths can vary in length from 7 feet for a single axle type to 100 feet for accommodating tandem trailers. A standard length is 70-80 feet. Single axle scales cost \$8,000-10,000 (40,000 lbs. capacity). A full 70 foot truck scale costs \$35,000-40,000 (100 ton capacity). Site preparation and the installation of a concrete base are extra.

Installation of a single axle scale will clearly save money, but will require the driver to weigh each axle individually and calculate a true weight.

Floor scales are designed to weigh small pallet size loads. The pitless electronic type are the most popular because they are economical and portable. Standard capacities range from 2,000 lbs. to 20,000 lbs. with standard platform sizes of 3' x 3' up to 7' x 5'. A 10,000 lbs, 7' x 5' floor scale with access ramps will cost \$7,000 - 8,000.

Bench scales are also available to weigh small loads of material. For capacities between 100 lbs. and 500 lbs. prices range from \$500 to \$3,000.

Scale Manufacturers

Aurora Scale Manufacturing Ltd.
P.O. Box 545
230 Edward St.
Aurora, Ont. L4G 3L6
(416) 773-6471
Bob Taylor

Butler Scale Systems
Distributor: RaRo Controls Ltd.
100 McLeary Court
Concord, Ont. L4K 2Z3
(416) 669-2260
John Dalla Rosa

Cardinal Scale Canada Ltd.
1220 Ellesmere Rd. Unit 22
Scarborough, Ont. M1P 2X4
(416) 291-5640
Robert Simanek

Masstron Scale Ltd.
1175 Appleby Line
Burlington, Ont. L7L 5H9
(416) 335-0600
Alan Briston

Toledo Scale
5 Dunbar Ave.
Hamilton, Ont. L8H 3E3
(416) 547-0153
Bob Elliot

APPENDIX A: END MARKET CONTACTS

Steel: Canadian Tinline Recycling Council
Bob Flemington or Joe Hruska
(416) 528-2386

Aluminum: Alcan Rolled Products Co.
Jocelyn Gagné (416) 229-6033

Glass: Consumers Packaging Inc.
Lynn Smith (416) 232-3268
Gord Stewart (416) 232-3197

Domglas Inc.
Dick Gomer (416) 823-3860

PET: Twinpak
David Bradwell or David Jones
(416) 275-5334

Newspaper: Ontario Paper
Bryan Allen (416) 227-1121

Belkin Paper
Peter McMann (416) 461-9241

Domtar Inc.
Mark Zeldenberg (416) 231-2525

I.G. Paper
(416) 457-0745

Sonoco Ltd.
(519) 752-6591

Therm-o-comfort
(519) 773-8498

Verdyol Mulch of Canada Ltd.
(705) 458-9601

Recuperation Cascades Inc.
(613) 523-6761

Strathcona Paper Co.
(613) 378-6672

Thermocell Insulation
(613) 523-3711

APPENDIX B: RECYCLING PROGRAM CLASSIFICATIONS

Class 1: Properly advertised weekly multi-material curbside collection of at least newspaper, glass and cans on the same day as garbage day, and using household collection containers.

Class 2: Multi-material curbside collection of at least newspaper, glass and cans on the same day as garbage day (usually weekly).

Class 3: Curbside collection of newspaper only.

Class 4: Depot collection of at least glass, cans and newspaper.

Class 5: Depot collection of newspaper only.

Notes (1) Class 1, 2 and 3 programs often also utilize depots for collection.

(2) A program can be a combination of Class 3 and 4 (curbside collection of newspaper and depot collection of glass and cans).

APPENDIX C: CURBSIDE MATERIAL GUIDELINES

The following are suggested guidelines for householders to follow when preparing recyclable material for curbside pickup:

- Newspaper:
- newspaper and inserts only.
 - bundled with plastic bags or string
 - no magazines, cardboard, telephone books, packaging, boxes, etc.
- Steel:
- steel food and beverage cans only
 - rinse food cans
 - no sealed containers (i.e. aerosol cans)
- Aluminum:
- used beverage cans only
- Glass:
- bottles and jars only
 - rinse; remove lids, closures, neck rings
 - no mirrors, lightbulbs or ceramics
- PET:
- PET beverage containers only
 - remove closures
 - flatten by squeezing with hands or stepping on bottle

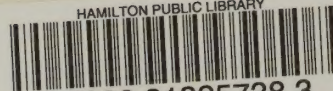
APPENDIX D: END MARKET MATERIAL SPECIFICATIONS

- Steel:
- tinplate steel food and beverage cans
 - flattened, baled or densified
- Aluminum:
- used beverage cans
 - mechanically flattened, baled or densified
 - moisture content less than 1% (i.e. must be protected from precipitation)
 - no steel, plastic or other contaminants
 - bale specs:
 - density 12 lbs. to 20 lbs. per cu. ft.
 - minimum size 30 cu.ft. with 2 ft. minimum and 6 ft. maximum in one direction.
 - preferred size 3' x 4' x 5' (60 cu. ft)
 - biscuit specs:
 - density 35 lbs. to 45 lbs. per cu. ft.
- Glass:
- glass bottles and jars
 - crushed cullet or uncrushed glass (broken or unbroken)
 - colour separated preferred
 - uncrushed specs: no ceramics
 - crush cullet specs:
 - no ceramics
 - no moisture during winter months
 - no deformed or broken metal closures.
- PET:
- baled or granulated
 - bale specs:
 - density 12 lbs. to 15 lbs. per cu. ft.
 - colour mixed acceptable
 - closures and labels acceptable
 - granulated specs:
 - colour separated
 - closures and labels acceptable

Newspaper

- loose or baled, depending on buyer
- quality and grading requirements depend upon buyer
- de-inking grade:
 - household newspapers & inserts only
 - all newspaper items must be removed (ie. plastic, string, magazines, telephone books, paper bags, wrapping paper, cardboard, etc.)

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